Appendix: MATLAB simulation.

```
function [P_loss,rate] = spill_over(method, N, Nlast)
% [P_loss,rate] = spill_over(methods, Nbalanced, Nlast)
% method: 1=slotted, 2=channel pairs, 3=spill over, 4=iterative, 5=optimal
% N = number of users per channel
% Nlast = number of users in last channel

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%
% 27-10-2000 written by Ofir
% tests ideas for advanced MAC to improve system capacity
%
% results
% K=20; M=15; p=1/2; trial_num = 400; Nlast=20
% * Regular algorithm (method=1)
% N =         20      21      22      24
% P_loss      .0008   .0016   .0031   .01
% rate        9.97    10.46   10.97   11.84
% * Two channels (method=2)
% N           22      23      24      25      26      27      28
% P_loss      3e-4    .0011   .0026   .005    .009    .015    .026
% * Non Iterative Spill Over algorithm (method=3, Nlast=20)
% N           27      28      29      30
% P_loss      .00045  .0014   .005    .014
% rate        13.3    13.79   14.2    14.52
% * Optimal (method==5) - Any request can be served by any channel
% N           28      29      30      31
% P_loss      7e-4    .005    .0167   .04
% rate        14      14.4    14.75   14.9
%
% conclusions:
% 1. Spill Over is better than conventional by 30% in throughput (or
% number of users) per given loss rate, at least with small M, such as M=15.
% 2. Spill over algorithm is pretty near the optimal algorithm, at
% least with large K, such as K=20.
% 3. Dual channel is better than single channel by 10% in number of users per similar loss rate.
%
% Nlast=20 is not optimal. Trying to optimize it, I gained less than 1% in rate.
%
% With M=60 (p=1/2,K=20) the improvements of methods 2 and 3 over the
% conventional one were only 5% and 11% respectively (at P_loss=.005)
%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

K = 20 ; % number of channels <== SHOULD BE EVEN IF METHOD 2 IS USED
M = 60 ; % number of slots that a channel can serve
p = 1/2 ; % probability that a user needs a slot

if ((method==1)|(method==2)) & ~(Nlast==N)
  error = 'Nlast should be equal to N'
end
```

```
% N = 17 ; % number of users per channel in the conventional system
% Nbalanced = 30 ; % number of users in channels 1:K-1 in the balanced system
% Nlast = 5 ; % number of users in channel K in the balanced system

trial_num = 400;

tx = 0; optimal_tx = 0; last_tx = 0; % reset transmission counters
loss = zeros(1,trial_num);

% slotted approach
for trial=1:trial_num;
  % simulate random slot requests
  req = [sum( rand(N,K-1)<p ) sum(rand(Nlast,1)<p)];

  % optimal performance bound (assuming all channels are a single channel
  optimal_tx=optimal_tx+min(M*K,sum(req));
  optimal_loss(trial) = max(0,sum(req)-M*K);

  if method==1
    % simulate regular (slotted) algorithm
    loss(trial) = sum( max(0,req-M) ) ;
    tx = tx + sum( min(M,req) );
  end
  if method==2
    % simulate regular (slotted) algorithm with channel pairs
    req = req(1:2:K)+req(2:2:K);
    loss(trial) = sum( max(0,req-2*M) ) ;
    tx = tx + sum( min(2*M,req) );
  end
  if method==3
    % simulate spill over algorithm (sub optimal)
    for k=1:K-1
      loss(trial) = loss(trial) + max(0, req(k) - 2*M);
      tx = tx + min(M, req(k)) ;
      req(k+1) = req(k+1) + min(max(0,req(k) - M),M) ;
    end
    % process last channel
    empty_slots_chan1 = max(0,M-req(1));
    loss(trial) = loss(trial) + max( 0, req(K)-M-empty_slots_chan1 );
    tx = tx + min( M+empty_slots_chan1, req(K) );
    ttt(trial) = max( 0, req(K) - M - empty_slots_chan1 );
    last_tx = last_tx + min( M+empty_slots_chan1, req(K) );
  end
end % for trial

if method==5
  tx = optimal_tx; loss = optimal_loss;
end

% show results
P_loss = sum(loss)/tx   % loss probability
rate = tx/K/trial_num   % average data rate per channel
```

```
optimal_P_loss = sum(optimal_loss)/tx   % loss probability
optimal_rate = optimal_tx/K/trial_num   % average data rate per channel

if method==3
  P_last_loss = sum( ttt )/last_tx
end

end
```

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* Three pages of specifications are Appendix.

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